

**Northeast Fisheries Science Center  
Narragansett Laboratory, Narragansett, RI**

**1) Most Recent Evaluation of the Lab - None available**

**2) Brief History and Mission**

The Narragansett Laboratory was established in 1966 as a marine recreational fisheries research laboratory of the Bureau of Commercial Fisheries. In 1970, following the Executive Order establishing NOAA, the Laboratory research was reprogrammed into the Northeast Fisheries Science Center to conduct research on early life stages on haddock, cod, and flounder stocks, apex predator research on Atlantic shark populations and to monitor and assess changes in ecosystem productivity effecting fish stock recover and sustainability. The Laboratory is located on three acres of federally owned land on the Bay Campus of the University of Rhode Island (URI). It is co-located with URI's Graduate School of Oceanography and the National Health and Environmental Effects Research Laboratory of the Environmental Protection Agency (EPA). The facility consists of a main building, an aquarium, and seven modular buildings.

*Mission: Research at the Laboratory is focused on providing scientific information supporting actions to protect, restore, and manage the use of coastal and ocean resources through ecosystem-based management. Studies are focused on the effects of changing oceanographic and ecological conditions of the US Northeast Continental Shelf ecosystem from the Gulf of Maine to Cape Hatteras in relation to the recovery of depleted fish stocks. Studies are also conducted on the demography and ecology of shark populations in response to oceanographic conditions, to provide information for shark management plans for sustaining those populations.*

Studies are conducted in support of two major objectives of NOAA's Strategic Plan: 1) protect, restore, and manage the use of coastal and ocean resources of the Northeast Continental Shelf ecosystem, and 2) manage and rebuild fisheries to population levels that support economically viable and sustainable harvests. The structure of the NE Shelf ecosystem has been seriously altered during the past 40 years. Bottom-fish stocks declined to an unprecedented depressed state especially for cod, haddock, and flounder. Stocks of Atlantic sharks have also declined. The pelagic herring and mackerel stocks have undergone major biomass changes from moderate levels of abundance prior to 1960 to virtual economic extinction by the mid-1970's followed by increases to about 6 million metric tons in 2001. Studies are focused on developing indicator reference points for organisms at the base of the food web of the ecosystem to assess the effects of short-term and long term changes of ecosystem conditions on recovery of fish stocks. Ongoing monitoring and assessment studies measure and forecast on the effects of changes in ecosystem productivity, zooplankton, nutrients, and physical oceanography on the fish-stock recovery process with regard to the availability of prey to early life stages of cod and haddock, and the growing biomass of herring and mackerel stocks. The life history data gathered on longline survey cruises by the Apex Predators Program on shark age and growth, food habits, reproduction, and migrations are critical sources of information used in the shark population rebuilding and recovery process underway by NOAA Fisheries.

### **3) Major Customers of the Laboratory**

NOAA Line Offices, Other Federal Agencies, State Resource and Environmental Agencies, and Academic Scientists and Students: Use of results of studies published or otherwise reported by the Laboratory staff.

NOAA Fisheries Offices and Divisions: Use of results of studies published or otherwise reported by the Laboratory staff.

Northeast Regional Office: Provide scientific support and data on regional fisheries and marine science issues.

Fishery Management Councils (New England and Mid Atlantic), and Atlantic States Marine Fisheries Commission: Prepare special reports on changing ecosystem conditions, oil spill impacts, environmental variability impacts, and biodiversity assessments.

Environmental Groups: The information on the changing ecological conditions of the NE Shelf ecosystem is taken into account in actions contemplated or put forward relating to ecosystem health and biomass yield issues.

### **4) Research Summary**

#### *Ecosystem Monitoring and Assessments*

Monitoring and assessment activities provide systematic Information on the changing physical oceanographic and biological conditions of the NE Shelf ecosystem related to 1) enhancing or delaying the recruitment of successive year-classes of cod, haddock, and other depleted fish stocks, 2) assessing and forecasting the effects of the population explosion of pelagic zooplanktivorous fish (mackerel, herring) on the prey and the productivity of the ecosystem using advanced technological oceanographic sampling methods including satellite remote sensing, research vessel sampling, undulating oceanographic recorders, and commercial ships of opportunity for towing sensors and obtaining samples. Seasonal and annual trends in the lower trophic levels of the ecosystem are monitored and assessed based on data from the plankton, nutrient, and hydrographic sampling. This provides fundamental quantitative information on the effects of environmental and oceanographic changes on the recovery of the demersal stocks, and the population explosion presently underway of the pelagic fish components of the ecosystem. Ecosystem monitoring and assessment activities also provide information on changes in Essential Fish Habitat, and in productivity trends for the entire 260,000 km<sup>2</sup> spatial extent of the NE Shelf ecosystem from the Gulf of Maine to Cape Hatteras. This Research is long term and regional.

#### *Ocean Productivity Research - Satellite Remote Sensing Research*

The Narragansett Laboratory serves as a center of expertise for marine applications of environmental satellite information. Researchers work closely with nearby URI satellite oceanographers and principal investigators from NASA and other NOAA components to develop state-of-the art algorithms and methods used to process and analyze satellite oceanographic data. Ocean primary productivity is a key ecological factor setting limits on an ecosystem's capacity for supporting fish stocks and fishery yields. The productivity investigation is producing and analyzing a multi-decadal, high resolution daily time series of phytoplankton primary productivity for the Northeast Shelf ecosystem that has been developed from satellite data (CZCS, SeaWiFS, MODIS, AVHRR). The satellite-based productivity estimates compare

favorably with historical *in situ* C-14 productivity measurements from earlier surveys of this ecosystem (long term study >5yr., supporting EBM/MRF) indicating no significant long term change in ecosystem primary productivity, indicating a robust base of the food web, sufficient to support the recovering demersal fish stocks and growing biomass of pelagic fish species. This research is long term and regional.

#### *CoastWatch - Satellite Remote Sensing Research*

With its history and commitment to an ecosystems approach in the study of the NE shelf ecosystem and its marine resources, the Narragansett Laboratory was selected by NOAA's CoastWatch Program as a prime location for its Northeast Regional site. The CoastWatch Program, established in 1990, serves as a regionally-sensitive distribution network for NOAA's rich collection of satellite data. Regional sites oversee the receipt, processing, and redistribution of near-real-time satellite imagery and derived products for use by marine researchers, environmental managers and the general public. At present, the CoastWatch Northeast Site serves over 100 registered federal and state institutions, universities, nonprofit research organizations and public schools as well as many research applications at the Narragansett Laboratory and the NEFSC. Under a long-standing cooperative agreement with URI (since 1982), support has been provided for the joint development and use of the Oceanographic Remote Sensing Laboratory (ORSL) at the Graduate School of Oceanography. Advanced facilities are also maintained at the Laboratory for the storage and analysis of very large data sets, and with over 20 years of satellite-derived sea-surface temperature data now available, extensive studies of the marine climate and its relationship to the living resources of the NE shelf are underway. This research is long term and regional.

#### *Plankton Demography*

Studies are carried out on the biodiversity, demography, and food web dynamics of the plankton community of the Northeast Shelf ecosystem. Analysis of population levels of copepod species of the NE shelf from the ecosystem monitoring data has shown that, although the overall biomass of zooplankton has remained relatively consistent, the abundance of smaller sized copepods, *Pseudocalanus* spp and *Temora longicornus*, increased dramatically in the early years of the decade, indicating a shift in the size composition of the forage organisms for larval and pelagic fish and a change in plankton community structure. The effects of the observed size-change are being examined in relation to the survival of early life stages of recovering fish stocks. Studies of age composition and growth of larval fish, based on otolith ageing of over 4000 cod and haddock larvae from 1995-1999 on Georges Bank, have shown that in 1998 there was a significantly greater abundance of older (30-70 day old) haddock larvae than in other years in the program, suggesting that the recruitment for the very successful 1998 year class of haddock was set during the larval period of the year class. This information is important input to forecasting models of recovery rates of cod and haddock stocks. This research is long term and regional.

#### *Gadoid Recruitment Research*

Research on the recovery of depleted gadoid (cod, haddock) on the NE shelf is focused on the physical and biological processes controlling the growth and survival of early developmental stages of cod and haddock and their zooplankton prey. Laboratory studies of key environmental factors controlling growth and nutritional condition of larvae are conducted using advanced molecular and biochemical techniques. Brood stocks of cod and haddock are maintained for experimental studies and for collaboration with other investigators in the US and Canada. As

part of the NOAA/NSF GLOBEC Georges Bank Program a five-year broadscale, multi-institutional cooperative study of the physical and biological factors controlling growth and survival of larval cod and haddock was completed (1995-1999). Analyses are underway on conditions affecting larval mortality, growth rate and prey field distribution and composition based on data from nets, pumps and advanced multi-frequency acoustic detection systems. Research is underway to enhance the development of a haddock culture industry through ongoing activities to maintain gadoid brood-stock and provide embryos for grow-out for a developing haddock mariculture industry. This research is long term and regional.

#### *Apex Predators Research*

Research is conducted on shark migrations, age, growth, reproduction, and food chain dynamics. Activities include international cooperative tagging, recreational tournament monitoring, resource surveys, and nursery habitat to support NMFS rebuilding program for recovery of depressed shark populations. Research is directed to commercially and recreationally important coastal and pelagic Atlantic sharks and includes the largest existing time series of data on the distribution and abundance of sharks based on 40 years of both shark tagging and recreational shark fishing tournament monitoring. The Cooperative Shark Tagging Program utilizes the efforts of thousands of recreational and commercial fishermen, student volunteers, and the public. Research on pelagic shark species is conducted with the international scientific community for age and growth studies, and population dynamics and movement models. Apex Predators research and resource surveys provide input to the NMFS Fishery Management Plan for Atlantic Tunas, Swordfish and Sharks, NMFS Highly Migratory Species Advisory Panel, NMFS Stock Evaluation Workshops, US National Plan of Action for the Conservation and Management of Sharks, Convention on International Trade Endangered Species of Wild Fauna and Flora, and International Commission for the Conservation of Atlantic Tunas, essential fish habitat, and ecosystems management activities. This research is long term and regional.

#### *Large Marine Ecosystem (LME) Research*

Laboratory staff is engaged in developing and applying the concept of large marine ecosystems as distinct geographic areas around the world for the assessment, monitoring, and management of marine resources for long-term sustainability and economic development. The concept was initiated at the Laboratory as a collaborative effort for the strengthening the linkage between advanced methods for assessing the changing states of large marine ecosystems. The Laboratory is the focal area for NOAA's LME activity. In collaboration with the Global Environment Facility, scientific and technical assistance is provided by the LME Program to developing countries in preparation and implementation of projects to introduce LME assessment and management practices using the NOAA/NMFS modular assessment strategy. Presently, \$650 million in grants and assistance is provided by the GEF and other donors to 126 countries in support of 17 LME projects in Asia, Africa, Latin America and eastern Europe. This research is long term and global.

#### *Fisheries and Habitat Restoration*

The Fishery Restoration Center (RC) component of the Narragansett Laboratory is focused on restoration of marine, estuarine and diadromous fishery resources and their habitats in coastal waters of the Northeast Shelf ecosystem. The Narragansett Laboratory's RC is committed to implementing quality restoration projects, advancing the science of habitat and species restoration, and monitoring the progress and performance of restoration activities to ensure healthy and sustainable fishery resources including efforts to restore and enhance bay scallop,

oyster, and quahog populations in Rhode Island's coastal ponds; \$1.5 million in settlement funds is being used to address shellfish injuries resulting from the 1995 North Cape oil spill through 2006. Project accomplishments included the release of millions of seed scallops, quahogs, and oysters into three coastal salt ponds and replanting eel grass at selected sites in Narragansett Bay. Monitoring suggests high transplant survival at several sites, and monitoring will continue for at least two years to evaluate performance. This research is short term, 0-2yrs., and regional.

#### *Ecosystem Indicators*

The baseline indicators used by NOAA and EPA to assess and monitor the changing states of the Northeast Shelf large marine ecosystem are derived from the National Estuarine and Coastal Program activities of EPA, and the Fisheries, plankton and oceanography monitoring and assessment activities of the NEFSC. Staff at the Laboratory is engaged with staff of the EPA Narragansett Laboratory in an integration of coastal and offshore indicators of changing states of the NE Shelf ecosystem. NOAA's comparable coastal indicator monitoring and assessment activities for the NE Shelf ecosystem are based on ecosystem-wide surveys of fisheries catch and effort data; multi-seasonal and decadal bottom and demersal fisheries surveys (e.g. demersal and pelagic finfish; squid, mollusks, and shrimp), zooplankton and oceanographic indicator surveys; and satellite remote sensing chlorophyll and primary productivity data. Ongoing coastal assessment activities of NOAA and EPA will provide a time-series of baseline indicators of ecosystem condition and should prove an excellent framework for accommodating the special needs of the states and local communities as assessment activities increase in response to the local conditions and needs for increased spatial and temporal assessments of changing ecosystem conditions. The combined NOAA-EPA time-series of indicators is serving as the baseline of the Ocean Ecology Observing system of NOAA Fisheries in the Northeast. This research is long term and regional.

#### *Fisheries, Socioeconomics and Governance*

Ecosystem-based management is a fundamental shift in the way living marine resources would be managed by and for society. It should not manifest as separate compartments the way that several pieces of legislation currently address single-species fishing standards, bycatch, habitat, and protected species. Living marine resources, and others associated with minerals, shipping, and defense, are integrated in reality by ecology, technology, and people's preferences. The many interactions should demand a management approach that looks at the aggregate as well as the parts. Within this perspective, on-going economics research at the Narragansett Laboratory can be divided into three areas: 1) applying portfolio theory to the management of multiple fish species under uncertainty; 2) investigating property rights arrangements that are compatible within an integrated, ecosystem framework; and 3) developing empirical estimates of resource value (versus the economic activity associated with landings) that can be added to the traditional National Income and Product Accounts (e.g., GDP). This research is long term and regional.

#### *Narragansett Bay Assessment and Monitoring Program*

The Narragansett Laboratory has established an ecological monitoring program for Narragansett Bay. Once every month a oceanic sampler with advanced biological, physical and chemical sensors is towed on a circular transect through the East and West Passages, Rhode Island Sound, Mount Hope Bay and the Providence River. The instrument undulates through the water column recording data including time, position, depth, temperature, salinity, chlorophyll fluorescence, dissolved oxygen concentration, primary productivity, zooplankton concentration and size distribution. The comprehensive study includes enhanced assessments of Narragansett Bay fish

and fisheries, a survey of sediment pollution in Narragansett Bay, a study of Bay currents and a network of fixed-site samplers recording a continuous record of hydrographic data. Agencies participating in this program include NOAA Fisheries, RIDEM, URI, Roger Williams University, Narragansett Bay National Estuarine Research Reserve and the USEPA. This research is long term and regional.

#### *Fish Health Assessment and Research*

Current monitoring and assessment efforts of this position at the Narragansett Laboratory focus on the pathogens of non-salmonid anadromous and marine fishes that may be vectors or alternate hosts of diseases that threaten ESA-listed Atlantic salmon, and on the few sea-run salmonids existing in Maine. Over 4,000 fish of various species have been examined over the past 4 years for viral pathogens and the agent of bacterial kidney disease. Only two fish have shown indication of viral exposure or retention and neither showed signs of disease, suggesting that non-salmonids are unlikely reservoirs of salmonid diseases in the northeastern US, unlike what has been reported elsewhere. The National Research Council of the National Academy of Sciences is contracted by NOAA to provide a search and review process for post-doctoral and senior scientists who conduct research in NOAA laboratories. The searches select the outstanding candidates in the fields of fisheries, oceanic, atmospheric and solar environmental studies. This research is long term and regional.

#### *Cooperative Marine Education and Research (CMER)*

Since 1989, the CMER programs with universities in the northeast have: 1) conducted cooperative research in areas of marine science, technology, policy, and resources, especially those related to regional fisheries; 2) provided marine education, primarily on the graduate level; 3) made facts, methods, and new finds discovered through research available to the public, to local state and federal officials, and to other interested parties; and 4) disseminated research findings by a variety of methods including publications, seminars, and workshops. To date, the CMER program has supported over \$7.5 million of NOAA/URI cooperative research. Since their inception, the CMER programs have provided opportunities for undergraduate and graduate students at the University of Massachusetts, URI, Virginia Institute of Marine Science, and Rutgers University to train at NOAA facilities, working alongside government scientists and resource managers. This is a regional, long term activity.

#### *NOAA Navigation Services*

The Office of Coast Survey's representative at the Narragansett Laboratory identifies the Northeast regional challenges facing marine transportation in general, directly supporting the NOAA strategic goal to "promote safe navigation." The resident agent assists the Coast Survey in overseeing the National Oceanic and Atmospheric Administration's nautical chart data collection and information programs, helping to meet constituent needs and provide coastal navigation services including new electronic technologies to help mariners and pilots significantly reduce the risk of accidents and spills. The representative resolves charting and navigation questions, educates constituents on emerging charting technologies and their uses, and solicits feedback on NOAA's navigation products and services from the commercial maritime industry. This is a regional, long term activity.

#### *Sharks*

Staff of the Apex Predators Program has conducted cooperative research on life history studies of coastal and pelagic shark species over the last several decades often in conjunction with

scientists at a variety of academic institutions. Current student research collaboration includes studies on the feeding ecology and nursery grounds of the sandbar shark, biology of the thresher shark, abundance indices and essential fish habitat of coastal sharks (URI Fisheries Animal and Veterinary Science Department), shortfin mako food habits, migrations and stock assessments (URI Graduate School of Oceanography); migrations and population dynamics of the blue shark (University of Washington School of Aquatics and Fishery Science); shark survivorship (Boston University), and tiger shark age and growth (University of New Hampshire). Collaborative studies are also underway with scientists at Moss Landing Marine Laboratory, Nova University, Natal South Africa Sharks Board, New Zealand National Institute of Water and Atmospheric Research, Florida State University, Canadian Department of Fisheries and Oceans, University of New England and coastal Atlantic states Division of Marine Fisheries.

#### *Cod and Haddock*

URI's Graduate School of Oceanography is collaborating with members of the Early Life Stage Dynamics staff in investigating the effects of bottom fishing and resulting habitat modification on the vulnerability of juvenile haddock to predation. This information will be used by fisheries managers when making decisions about fishing practices that modify habitat. A joint pilot study is underway with URI on broodstock management and development of grow-out methods for rearing cod and haddock larvae for market and stock enhancement. The Laboratory is the only facility in the US with existing expertise and capacity for producing large numbers of cod and haddock embryos. New methodologies for determining larval cod, growth, and fitness have been developed for use in studies of recruitment variability on Georges Bank. These studies are conducted in cooperation with a variety of investigators from academia and other NMFS facilities. GLOBEC collaborators include the University of Maine, WHOI, UNH, URI/GSO, and Belle Baruch Marine Institute, as well as ongoing cooperation and training with other fisheries laboratories in the Southeast and Alaska Fisheries Science Centers. Utilizing its rearing facilities and biochemical laboratory, we collaborate with URI, UNH, Univ. of Maine, Univ. of South Florida, Great Bay Aqua Farms, and Swans Island Cod Hatchery, among others. The investigation is part of a broad-based effort in cooperation with state and private sectors to further enhancement of cod and haddock in the northeast.

### **5) Major Accomplishments in the Last 5 Years**

- Completed a study of key Northeast Shelf primary productivity, zooplankton, and oceanographic indicators serving as multi-decadal reference points, characterizing the base of the ecosystem as a relatively stable food source for recovery of demersal fish stocks and a growing biomass of pelagic species. *Application:* input to forecasts on expected rate of recovery of demersal fish stocks; science-based ecosystem reference points.
- Continuing multi-decadal research on shark migrations, age, growth, reproduction, food chain dynamics, international cooperative tagging, recreational tournament monitoring, resource surveys, and nursery grounds in support of HMS and ICCAT assessments. *Application:* information is important input to estimates of shark stock levels along the Atlantic coast; scientific publications.
- Development and application of new biochemical methodologies for determining the physiological condition of larval cod and haddock. *Application:* scientific publication, regional, national, and global applications.

- Development and application of a new algorithm for the NOAA/NASA SeaWiifs satellite sensor for ocean productivity. *Application:* scientific publications, NASA/NOAA scientists, significant contribution to state, regional, national and global science.
- Successful production from resident brood stock of viable fish eggs and larvae of cod and haddock for use in early life history studies of survival and, also, for mariculture applications. *Application:* scientific publications, collaboration with private sector in support of developing mariculture industry in the Northeast.

## **6) Legal Mandates**

MSFCMA - Magnuson-Stevens Fishery Conservation and Management Act  
SFA - Sustainable Fisheries Act  
DQA – Data Quality Act

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